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OBSERVATIONS ON PACHYCORIS TORRIDUS (SCOP.), WITH REMARKS ON PARENTAL CARE IN OTHER HEMIPTERA.

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I.

In east-central Paraguay the Scutellerid *Pachycoris torridus* is most frequently found on the under side of the leaves of a small, scraggy, rough-barked tree called the *curupí-cahú*. This plant is of the family Euphorbiaceae, and Mr. Pedro Jorgensen, of Villarrica, informs me that the botanists know it by the name *Sapium haematospermum*. On the sandy plains north of Caa Guazú this tree occurs singly or in groups of two or three, and only rarely is there any bushy growth about their bases. Usually the *Sapium* is much less than ten meters in height, but on better soil or on terraces above the streams it sometimes exceeds this size.

Two other Hemiptera, in my experience, are also primarily associated with the *curupí-cahú*. One is a Coreid whose description will shortly appear under the name *Anasa sapiicola*, a species whose eggs and nymphs, like the adults, occur in mid-summer on the developing fruit. The other is an unidentified Bryocorine Mirid which occurs on the leaves. Neither of these, however, approaches in interest *Pachycoris torridus*, as this species adds another to the relatively few which are known where the parent stands guard over the eggs and the young nymphs.

Pachycoris torridus is a highly variable species, but the specimens I took in Paraguay in 1931–32 are more constant in their coloration than others I have seen, and none of them can be referred to either of the varieties named by Breddin (1). The ground color varies from pale sepia to black, with the extremes less numerous than the intermediates. The pronotal red spots apparently are always eight in number, though the two on the median

line sometimes are extremely reduced, to mere points or short narrow lines. Berg (2), speaking of the Argentine specimens, says there are usually thirteen scutellar spots, the median one of the third transverse row commonly being absent. In my Paraguayan material the scutellar spots commonly are fourteen, arranged in four transverse rows of five, four, three, and two spots respectively. But in about one-fifth of my specimens there are only twelve spots, as the two median ones of the *second* row are absent. All the spots are narrowly edged with black, but in darker specimens this is progressively less evident until finally no such margin is visible on individuals whose ground color is black.

I first took this species on December 31, 1931, from a *curupí-cahú* growing on a narrow terrace above a small stream. Subsequently I discovered individuals on other trees of the same species, both in similar situations and on the arid campo; and once only I found a specimen, with its eggs, under the leaf of a different plant near the place where my first specimens were seen. All the *Pachycoris* I found, up to the time of my departure late in January, were on the under side of the leaves, and almost half of them were standing over their eggs when discovered. It is interesting to note also that I secured ten times as many females as I did males of this species.

The leaf of the *curupí-cahú* is smooth-surfaced, long and narrow, in shape not unlike the leaves of many willows common in eastern North America, and its margins are entire. The lower surface is longitudinally elevated slightly by the mid-rib, but is hardly broken by other veins. The leaf, for about three-fourths of its length, is about 9 to 10 mm. wide—or, in other words, is of about the same width as the *Pachycoris*.

The individual eggs of *Pachycoris torridus* are oblong-elliptical, and measure about 1.3 x 1 mm. The chorion is unmarked, as seen under low magnification (10x), and no chorial processes are visible near the anterior pole. The eggs are deposited in flat plaques, each ovum glued to the leaf surface at its caudal end, and the number of eggs per plaque averages probably about 100. I have found masses with as few as 50 eggs, and others with nearly three times that number. Throughout the greater portion of the plaque the eggs are regularly arranged, in straight lines intersecting at angles of 60°, so as to produce a honey-comb pattern in the mass as a whole. Near the edge of the mass, apparently among the eggs laid last, the regular pattern is often more or less lost and the ova are irregularly disposed, but this seems to be true only of the larger egg masses.

When first laid the eggs are pale honey yellow, this color being due to the appearance of the yolk as seen through the semi-transparent chorion. As the embryos develop they rapidly acquire a red pigmentation, visible first in the eye and along the legs, and the egg mass generally acquires a reddish color as a result. Here and there in the mass may be seen eggs which fail to develop, whose yellow hue makes them conspicuous. In my specimens these amount to about 10 per cent of the total number, and their position or arrangement in the plaque is most haphazard.

At the edge of the mass, though commonly only in the larger plaques, may be seen other eggs which also do not develop, and which are readily recognized by their grayish or blackened appearance. Though I have no direct observations on them to support my belief, I regard these as infested with hymenopterous egg parasites, as I have observed similar phenomena in the egg masses of other Hemiptera. Ayyar (3) has observed *Telenomus indi* emerging from similarly blackened eggs of the Indian *Cantao ocellatus,* a Scutellerid with similar brooding habits; and like myself he found these blackened ova only at the edge of the egg mass. In *Pachycoris torridus* the blackened ova may amount to as much as 15 per cent of the total number of eggs in the mass, and in my experience they occur only in that part of the mass which is beneath the caudal end of the parent as she stands over them.

Throughout the period of incubation, and even throughout the first nymphal stage after the young emerge, the parent *Pachycoris* stands guard over her brood. The *curupí-cahú* leaf, as has been said, measures 9 to 10 mm. in width, and the egg mass occupies nearly its entire breadth. In length the plaque may measure somewhat more, and the average dimensions, I would say, are about 9 x 11 mm. Thus the mass commonly occupies an area just about as great as can be covered by the adult bug. After emergence the young do not move about at once, but commonly remain huddled for a time in a mass whose area is nearly the same as that of the egg mass, but of somewhat greater depth.

Whether the female takes food from the plant during this time is a question I cannot answer. Certainly she does not move about, nor can she be driven from her position, although *Pachycoris torridus* flies rather readily under other circumstances. If approached from either side while brooding over her eggs or young, the bug most commonly tips her body toward that side, pivoting as if on a longitudinal axis, so as to present the dorsal side of the body toward the approaching menace. Ordinarily, if the bug is approached from in front, the antennae are extended with their tips against the leaf

and the anterior part of the body is lowered as if to shield the nymphs or the eggs from view, and consequently from harm. If one approaches closer, the insect will sometimes start swaying from side to side with abrupt, jerky movements of the posterior part of the body, the head and the fore legs being kept motionless; and these jerky movements may be strong enough to cause the leaf to flutter as if in a breeze, or to be plainly felt if the end of the leaf is held in the fingers. At the same time the wings and the scutellum may be slightly raised. Only once did I observe an individual which lifted its wings and raised the fore part of the body as if to attack the approaching enemy. Excepting only the jerky movements referred to, all the changes of position made by the *Pachycoris* under these conditions are very slow and deliberate, and the bug gives an impression of extreme clumsiness.

The normal position of *Pachycoris* on the leaf is longitudinal, and commonly the head is directed toward the distal end of the leaf. Often the bug stands with its claws hooked under the edges of the egg mass, and if the insect is lifted from its place very frequently the entire egg mass is torn away from the leaf and is then held in the air by the bug, firmly gripped with the claws of all six feet. At other times the claws may be hooked over the edge of the leaf, gripping the latter so strongly that the plant tissue may be torn and a flow of latex started if the bug is removed. I have rarely seen a *Pachycoris* change its position on a leaf or even move its feet when approached; and on more than one occasion I have removed leaves from the trees and handled them for ten minutes or more without causing the bugs to move.

II.

It is surprising that this remarkable habit of *Pachycoris torridus* has not previously been reported in the literature. The species is a common one throughout much of South America, and it would seem that its behavior must surely have been noted by some naturalist before this. Mr. H. G. Barber, in conversation, has told me of a similar habit in an Antillean species of the genus, probably *P. fabricii,* but I have failed to find an account of it in his papers or in any other publication in my library.

This species is one of the Tetyrine Scutelleridae, and the only one I know of for which such a habit has thus far been described. On the other hand, two Oriental species of the subfamily Scutellerinae, belonging to closely allied genera, are known to exhibit phenomena which are almost precisely similar. *Tectocoris diophthalmus* (= *T. lineola*), according to Dodd (4), attaches its eggs to

upright twigs and then stands over them until they hatch. Ballard and Holdaway (5), in a life-history study of this cotton pest in Queensland, have confirmed Dodd's statements, though modifying them to some extent. Apparently, in this species the female may occasionally leave her eggs but will always be found near-by, and her brooding may continue for as long as seventeen days. Ballard and Holdaway also report having the adult bug move her body so as to interpose it between her eggs and Chalcidid wasps which were buzzing around as if attempting to reach them.

The brooding of a second Scutellerine, *Cantao ocellatus,* seems first to have been referred to by Lefroy (6), and has been the subject of a study by Ayyar (3), to which reference has already been been made. Unfortunately I have not been able to utilize Takahashi's paper (7) dealing with this species. In India *Cantao ocellatus,* according to Ayyar, deposits its eggs on the leaves of a Euphorbiaceous tree, *Trewia nudifolia,* and its brooding habits seem precisely similar to those I have described for *Pachycoris torridus,* except that Ayyar does not mention any jerky swaying movements from side to side like those occasionally seen in the Paraguayan species. The first mention of brooding habits in the Scutelleridae was published by Montrouzier (8), but without definite reference to any one species. Kirkaldy (9) believed that his account referred probably to *Tectocoris diophthalmus,* but in my opinion it might equally well apply to *Cantao ocellatus,* or possibly to some other species.

Not the least amazing feature of the performance given by these three insects is their close conformity with that of the European Pentatomid *Meadorus griseus,* whose habits were first noted by Modéer (10) and DeGeer (11). Their accounts were ridiculed by Fabre (12), but Kirkaldy (13) has shown conclusively that Fabre, with his unfortunate disregard for the systematic phase of entomology, had not even troubled to obtain for his experiments the same species which had been observed by those earlier writers. The observations of Modéer and DeGeer have since been confirmed and amplified by a number of competent observers: an excellent summary of *Meadorus griseus* is given by Butler (14), and figures of the brooding insect have been published by Heymons (15) and Nielsen (16), the latter from a photograph. In addition to the papers cited by Kirkaldy (13) and Butler (14) on *Meadorus griseus,* I may call attention to the remarks of Schouteden (17), Jensen-Haarup (18), and Schumacher (19) on various phases of its brooding habits.

On comparing the behavior of the Paraguayan *Pachycoris torridus* with that reported for the European birch-tree bug, *Meadorus griseus,* I am struck with the almost complete agreement between the two, even down to small details. And this is the more remarkable when we consider that *Pachycoris* and *Meadorus* are not closely related forms and that they occur in widely separated regions. Indeed, all the reported cases of brooding in the Hemiptera occur by ones or twos in regions far remote from one another; and usually single species only are concerned, while their nearest relatives display no such behavior. No such case has yet been reported, so far as I am aware, for any Pentatomid or Scutellerid in Africa or in North and Central America, if we except the doubtful one mentioned by Rau (20) of a female *Mecistorhinus tripterus,* found with second instar nymphs on a banana imported into Missouri from tropical America, an association which may have been purely fortuitous. Africa and North America, however, have given us instances of parental care in other very distinct groups of Hemiptera.

In North America brooding has been reported in two species of Tingidae and in one species of the Mezirine Aradidae. The Tingidae referred to are *Gargaphia solani* and *Gargaphia tiliae.* Weiss (21) speaking of the latter, remarks that a female is always in attendance during the incubation period of the eggs, though apparently she does not stand over them in the manner described above for the Pentatomoids; and each cluster of nymphs usually has a female standing near-by until the young are fully grown. Fink (22) writing of *Gargaphia solani,* describes a similar habit in this species, and adds that if the brood of nymphs migrates from one leaf to another, the female directs the way and keeps the nymphs together during the march by stroking or pushing them with her antennae. I may add that I have seen what I take to be similar family groups of nymphs with guardian adults in a third species of Tingidae (unidentified) occurring on *Cordia corymbosa* in Paraguay, but I first discovered this species almost at the end of my stay, and consequently had no opportunity to observe its habits closely.

In Texas McClure (23) reports the Aradid *Neuroctenus pseudonymus* as laying its eggs in masses of from ten to fifty ova, in the channels cut by wood-boring insects under the bark of a dead oak tree. After oviposition is completed and the female has departed from the scene, another adult (which McClure thought was probably the male) crawls astride the eggs and remains there im-

mobile for two weeks or so, until the eggs hatch. The young nymphs of this species, like those of *Pachycoris torridus,* remain clustered under their guardian for a day or two after their emergence. On removing specimens to the laboratory, McClure found that the brooding instinct in *Neuroctenus pseudonymus* is strong enough to overcome the normal negative phototropism of this species, the brooding individual being the only one which failed to migrate to the darker side of the piece of bark when exposed to a strong light.

From Africa comes the amazing case of a Reduviid, *Rhynocoris albopilosus.* Bequaert (24) first reported that the female of this species stands over the eggs, but a year later he published a correction (25) stating that it is the *male* which performs this task. The eggs are attached to herb stems at heights of about 30 cm. from the ground, in single plaques containing about two dozen eggs, arranged in two to five irregular rows. The insect stands over them with the venter almost touching the eggs, and if alarmed it may run up and down the plant stem but does not fly. This behavior was noted by Bequaert on three occasions, in the Belgian Congo, and he reports having seen the watchful bug repulse Chalcidid wasps from the eggs which it was protecting. After the young emerge they run about on the plant stem and frequently will be seen walking over the guardian adult.

Cantao ocellatus and *Tectocoris diophthalmus* are closely related forms, and possibly the behavior of these two species may be of common origin: but this is doubtful in view of the absence of similar habits in other species of *Cantao,* as far as they have been reported. In this connection, however, we must bear in mind the possibility that Montrouzier's remarks may refer to one or another species of *Cantao.* There is a strong probability of common origin for the habits observed in the two species of *Gargaphia,* but the brooding habit must certainly have arisen independently in each of the other cases where it has been observed—unless we are to accept the untenable alternative that the brooding habit was once general throughout a great part of the terrestrial Hemiptera and that these few species are the only ones in which it still persists.

In the Hemiptera, then, we have the remarkable phenomenon of a certain type of parental solicitude which has appeared independently in seven (or eight?) different families or subfamilies, and in each of the major zoogeographical regions. One of these involves a Reduviid, the others are all phytophagous forms; in one, or possibly two, cases it is the male that is concerned; in the others

the female is said to be the guardian. These instances are as follows:

Scutelleridae: (females)	*Tectocoris diophthalmus* (Scutellerinae). Australia, etc.
	Cantao occllatus (Scutellerinae). India to Papua.
	Pachycoris torridus (Tetyrinae). South America.
Pentatomidae: (females)	*Meadorus griseus* (Acanthosomatinae). Europe, Siberia.
	Phloeophana longirostris (Phloeinae). Brazil.
	?*Mecistorhinus tripterus* (Pentatominae). Tropical America.
Aradidae: (males?)	*Neurocenus pseudonymus* (Mezirinae). North America.
Tingidae: (females)	*Gargaphia solani.* North America.
	Gargaphia tiliae.. North America.
Reduviidae: (males)	*Rhynocoris albopilosus.* Belgian Congo.

Formerly, in considering the significance of the brooding habit in *Meadorus griseus,* as also the egg-carrying habit of the North American *Belostoma flumineum,* it was usual to assume that both of these phenomena had as their aim the protection of the ova from the male of the species, to which were imputed cannibalistic traits plus an extremely voracious appetite. This view, however, has been opposed by several writers and is no longer generally held; and the case of *Rhynocoris albopilosus,* a predatory species, in which the male is the guardian of the eggs, offers direct evidence against this theory. In this connection, it would be interesting to know if, in the other cases enumerated, it is *always* the female that is concerned.

Another explanation, and a more reasonable one, I believe, of these phenomena is the protection afforded the ova against egg parasites. In support of this we have the direct observations of Bequaert and of Ballard and Holdaway, cited above, and the indirect evidence that parasitized eggs are found only at the edges of the egg mass, where they are less effectively covered by the guardian adult, as observed by Ayyar and myself.

III.

In tracing the development of the parental instinct in the Hemiptera, it is difficult to know where to begin. It is a matter of common knowledge that the phytophagous forms, at least, habitually

deposit their ova upon some preferred food plant from which the newly hatched nymphs can extract suitable nourishment upon beginning their independent existence. This can not be cited as a case of parental care, as the parent leaves the scene at once when oviposition is done and has no further care for her young. The curious habits of some Belostomatids whose females attach their ova to the backs of the males must be eliminated, as also the case of the Coreid *Phyllomorpha laciniata,* whose females, according to Jeannel (26) deposit their eggs upon the spinose backs of others of their kind, males or females, indiscriminately. In both of these cases the guardians of the ova are pressed into service to carry the eggs until they hatch; and in the case of *Belostoma flumineum* at least, there is evidence that the male is a most unwilling accessory to incubation.

Bueno (27) has found specimens of *Halobates* with ova attached to the abdomen externally, and Bouvier (28) writes that in these marine Gerridae the eggs "sont réunis sur le dos de la femelle," a statement I have not seen confirmed by any other author. If this unusual, not to say impossible, condition does obtain in *Halobates,* then we should have to consider it as a very primitive type of maternal solicitude, and a phenomenon entirely unrelated to the protection of the ova against egg-parasites. As to the condition described by Bueno, although he writes me that it is of frequent occurrence, I prefer not to consider it at length in view of our scanty knowledge of the ethology of these insects.

T. C. Barber (29) has given us an account of a very interesting performance in the Pyrrhocorid *Dysdercus obscuratus* which evidences an advance toward maternal solicitude on the part of this bug. Eggs are laid in pieces of the preferred food plant, *Sida* sp., which have fallen to the ground, or near such pieces, and the female then covers them with earth, piling dust over the plant tissues and the eggs alike. The first instar nymphs appear to live underground, feeding upon the plant matter provided by the parent, and nymphs of the second instar may do likewise during most of this stage. I did not personally observe any such behavior on the part of the common Paraguayan *Dysdercus ruficollis,* which likewise feeds principally on *Sida* spp., but I do not exclude the possibility of its occurrence as I noted a conspicuous absence of the smaller nymphs on this plant, though older ones, like the adults, were abundant in December and January.

This seems to be the only instance of this sort reported for the Hemiptera, and it is definitely a step forward on the road toward parental solicitude, being comparable to such cases as the Scara-

beid beetles which provide pellets of dung before oviposition so that the larvae are supplied with the food which they will consume during their underground existence, or the solitary wasps which lay their eggs upon their paralyzed prey and then bury them beneath the soil. In none of these, however, is there any actual personal care displayed by the parent toward the young during incubation or early life. The brooding habits of the various species referred to above represent a very great advance over the case of the *Dysdercus,* since here the parents stand guard over the young until they emerge, or even longer.

Similar brooding habits are also observed in the curious Brazilian *Phlocophana longirostris,* a Pentatomid of the subfamily Phloeinae. But here there is still a further advance, in that the female is reported actually to carry her young during their infancy. Heymons (15) reports a parallel case in an Emesine Reduviid of the genus *Ghilianella,* but I have been unable to locate the original reference for this and therefore pass it by without further mention.

The habits of *Phlocophana longirostris* were the subject of a brief account by P. S. de Magalhães (30), first published in a daily newspaper in Rio de Janeiro and reprinted shortly afterward by R. von Ihering (31). The publications where these notes appeared are so inaccessible to most entomologists that I give here an abstract of the account written by Magalhães. It should be noted that he uses the name *Phlea admiravel,* a Portuguese translation of *Phloea paradoxa,* with which species he confused the form under observation. Brien (32) has more recently given an account of the early stages of a "*Phloea paradoxa,*" but since I have been unable to see his paper, I can not say whether he was treating of the same species as was Magalhães.

According to Magalhães, the curiously flattened *Phlocophana,* with its broadly explanate and deeply excised margins, so closely resembles a patch of lichens on the tree trunks or branches where it occurs that it is easily overlooked. The Phloeines, like other Pentatomids, have odoriferous glands which secrete highly volatile, non-staining liquids: in some individuals the secretion is most offensive in odor, in others quite agreeable, even in different specimens of the same species taken from a single tree. If these bugs are handled for any length of time, the fingers become almost indelibly stained a rusty yellow color, apparently from the secretion of small glands in the dorsal integument. A most unusual defence reaction is observed in these bugs: if disturbed they eject a jet of clear, limpid liquid from the anal orifice, often to a considerable distance. Only a slight stimulus is needed to provoke this reac-

tion, and even the pressure of a strong wind is sufficient, so that where the bugs are numerous the drops of liquid fall on a windy day like a shower from the trees. This discharge is neutral or very weakly acid in reaction, and is non-irritating even when received on the conjunctiva of the eye. The bug walks only very slowly, with a curious hitching movement of the hind part of the body; and it flies with great reluctance unless it is dropped from a considerable height.

"During the development of the ova," says Magalhães, "from oviposition until hatching, the mother *Phloea* remains steadfast at the point on the bark where they were laid, and covers them with her body." After hatching, the nymphs attach themselves to the venter of the parent and are carried by her for many days. "It is to be presumed that they are fed by their parent," Magalhães continues. "In what way this service is performed, we do not know. The position of the little ones, holding on to the parent, their backs turned to the surface of the tree where the parent lives, and the softness of the rostrum in the newly hatched nymphs, are reasons for supposing that the latter receive their food from the parent. In spite of our interest and our close attention, we could not discover whether the parent spreads over her abdomen the sap she has drawn from the tree, or whether the feeding takes place in some other way. . . . Although delicate, fine and flexible, the rostrum of the adult penetrates deeply through the cortex of the tree in search of the sap which provides its food. It can be withdrawn only with difficulty when in this situation, and the insect may even be left suspended by its rostrum without the latter being pulled from the tree trunk."

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